SEMICONDUCTOR R&D PROGRAMS
Essential Innovation for U.S. Technology Leadership

To win the competition for technology leadership in industries enabled by semiconductors—such as artificial intelligence, high performance computing, advanced communications, quantum, energy, and defense—the U.S. must reaffirm itself as the epicenter of innovation for the semiconductor industry's newest technology paradigms. To this end, the U.S. is investing in high impact R&D programs to secure the next generation of semiconductor innovation.

The industry's most powerful avenues for innovation have given rise to a need for new and more collaborative R&D programs that bridge players across the semiconductor value chain—from design, software, and architectures to materials, fabrication, and advanced packaging. In addition to essential federal investments in basic research and other efforts that have provided the traditional approach for advancing innovation and training the innovation workforce,[1] new programs are adopting a fresh approach to public-private collaboration in technology development to meet the changing nature of the industry as it moves beyond Moore's Law.

Four Department of Commerce R&D programs are making progress toward an aggressive, comprehensive, and industry-aligned strategy to ensure the most cutting-edge semiconductor technologies are developed in America, made in America, and benefit the American economy and workforce.

National Advanced Packaging Manufacturing Program (NAPMP)

National Semiconductor Technology Center (NSTC)

Semiconductor Manufacturing and Adv. Research with Twins USA (SMART USA) Institute

CHIPS Metrology Program

KEY TAKEAWAYS

01 To win the global competition for technology leadership, the U.S. must maintain its role as the leader in semiconductor innovation.

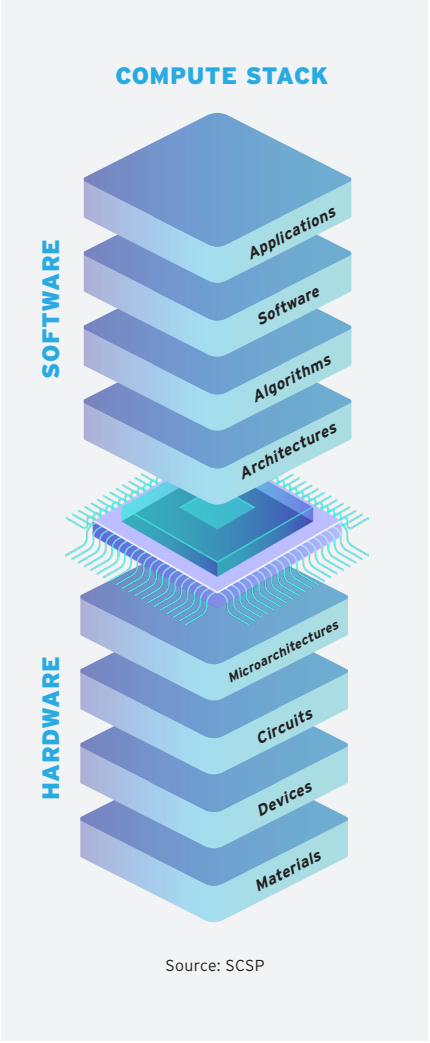
02 The CHIPS R&D Programs have the potential to deliver on an aggressive, comprehensive, and industry-aligned strategy that reflects the newest innovation trajectories in the industry.

03 These programs have made progress in deploying their resources to award recipients, and several of those projects are now underway. The programs have started to develop needed infrastructure, with final contracts in place for smaller sites and larger facilities under contract negotiation. More progress is needed to define the research agenda, consistent with industry priorities and the needs of high volume manufacturing, and begin implementation of this agenda.

04 As these programs continue to be implemented they must be sustained at the appropriated levels and maintain their commitment to industry-informed programming.

IMPORTANCE: THE EVOLVING DYNAMIC OF MOORE'S LAW AND BEYOND

Important pathways for semiconductor innovation have emerged in recent years and will continue to expand, requiring fresh approaches to collaboration and technology development. In prior decades, advancing compute performance in the chip industry was achieved primarily through "scaling"—miniaturizing features on a chip and accommodating more transistors onto a single piece of silicon. "Moore's Law" predicted that the number of transistors on a chip would double every two years. This model of innovation yielded remarkable benefits for decades, and the march of Moore's Law continues. However, novel innovation frontiers hold immense promise for dramatic leaps in compute performance. These new methods push beyond Moore's Law and appeal to "full stack" strategies—innovating across software, materials, design, architectures, and packaging—and demand collaboration throughout the value chain. Further, as the industry diversifies to new end markets, customers have new demands apart from increased compute performance, such as ultra-low power consumption, high bandwidth, the ability to operate at higher voltages regimes, stability at higher temperatures, or low latency.



Source: SCSP

TAKING ACTION: EXTENDING U.S. LEADERSHIP FOR THE FUTURE OF SEMICONDUCTOR INNOVATION

New demands from customers are expanding how the semiconductor industry innovates, and new semiconductor R&D programs are poised to provide the infrastructure and collaborative research platforms to ensure the American semiconductor ecosystem remains ahead of our global competitors across these various innovation dimensions.

Collectively, the four CHIPS R&D programs fill two voids in the U.S. semiconductor ecosystem:

01	**Bridging the "lab-to-fab" gap to transition early research to commercially relevant technology**
02	**Establishing collaborative research infrastructure that allows industry competitors to work in a pre-competitive space to propel the industry's newest, full-stack innovations.**

	Overview	R&D Focus & Facilities	Approximate Funding*
National Advanced Packaging Manufacturing Program (NAPMP)	Support advanced compute for artificial intelligence, high performance compute, and niche systems, the NAPMP is deploying a comprehensive strategy to secure this emerging and high-value-add sector in the U.S.	**6 research topics:** • Awards Announced: materials/substrates • Final Applications Submitted: photonics and connectors, co-design & EDA, chiplet ecosystem, equipment/tools/ processes, power delivery and thermal management **Advanced Packaging and Piloting Facility:** Natcast contracted as operator of fully integrated advanced packaging pilot line	**$3 billion**
National Semiconductor Technology Center (NSTC) *Operator: Natcast	Support transition of early-stage research to commercially relevant technologies and build full-stack innovation programs for stakeholders across the value chain. Support workforce development.	Collaborative facilities to expand access to valuable innovation assets: • Piloting and Prototyping Facility • EUV Accelerator • Design and Collaboration Facility	**$6.355 billion**
Semiconductor Manufacturing and Advanced Research with Twins USA (SMART USA) Institute	Develop digital twins as an innovation tool to simulate and optimize process developments without the time and expense of physical trials. SMART USA aims to reduce chip development and manufacturing cost by 40% and development cycle times by 35%.	• Create the "Digital backbone" • Establish industry-wide standards • Build a network of shared facilities • Launch a digital marketplace • Expand the digital-twins capable workforce	**$285 million**
Metrology Program	Driving the industry's ability to make critical measurements for process verification and failure analysis.	• Hardware programs at NIST facilities • Digital assets including data sets, references, and software libraries	**$252 million**

Source: Department of Commerce Office of Inspector General

CONCLUSION

As innovation pathways evolve in the semiconductor industry, so too must American research programs to lead in the new innovation landscape and compete with global challengers. Collaborative research consortia are emerging around the world to build the synergy needed to accelerate the next generations of microelectronics technologies. China continues to increase its research investments in semiconductor technology as a means of displacing U.S. leadership, driving billions of dollars into research institutes to elevate public-private semiconductor innovation.

Taken together, the four Department of Commerce R&D programs discussed above are taking steps to create the infrastructure and capabilities for the U.S. semiconductor industry to engage in collaboration and technology development needed to build American leadership in the technologies of the future. To secure the heart of semiconductor innovation and continue growing domestic capacity, federally funded research remains critical to a holistic strategy of strengthening the competitiveness of the semiconductor industry in America.

1 Basic research funded at the National Science Foundation (NSF), the National Institute of Science and Technology (NIST), and the Department of Energy Office of Science are essential to the U.S. remaining the technology leader. Defense-focused programs at the Defense Advanced Research Projects Agency (DARPA) and Office of Research & Engineering (OUSD(R&E)), as well as new programs such as the Microelectronics Commons, help ensure the U.S. is at the forefront of defense technology needed to enhance our national security.